Building a "Pop Rocket" to Demonstrate Newton's Third Law

By Diane K. Fisher

This activity is from The space Place, a children's Web site created by the Jet Propulsion Laboratory (JPL) of the California Institute of Technology, Pasadena, California, in conjunction with the International Technology Education Association (ITEA). (JPL works under contract to the National Aeronautics and Space Administration (NASA).)

In this activity, children, either individually or in pairs, build a paper rocket powered by effervescent antacid tablets (such as Alka Seltzer®). The rockets can be built indoors, but should be taken outdoors for launching. This activity is a simple, yet fun and memorable way to demonstrate Newton's third law and the principles of rocket and jet propulsion. The activity leads to a discussion of how all rockets work to get spacecraft into orbit or on their way to "deep space" destinations.

Students can exercise their creativity in designing their rockets. They can compete to see whose design goes highest, takes off soonest (or latest), or looks the most unusual. Comparison can be made of differences in performance using more or less water, bigger or smaller pieces of antacid, or vinegar instead of water. The activity can be an occasion to practice careful observation of different trials and to keep careful records of results. Or, it can just be an opportunity for creativity and fun.

Materials

Paper, regular 8-1/2- by 11-inch paper, such as computer printer paper or even notebook paper.

Plastic 35-mm film canister (see below)

Cellophane tape

Scissors

Effervescing antacid tablet

Paper towels

Water

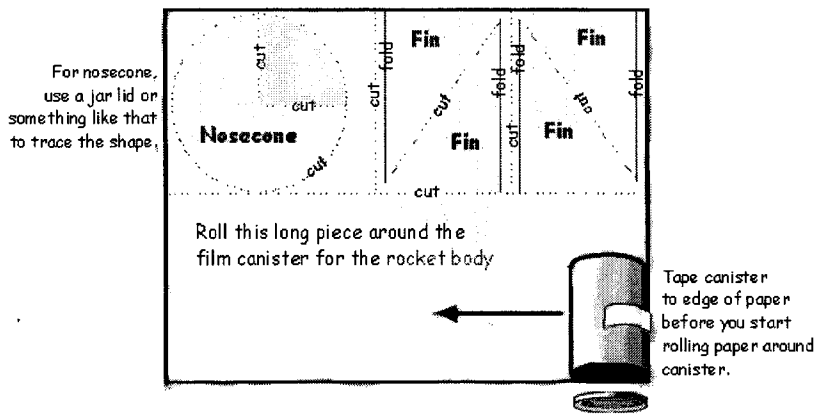
Eye protection (like eyeglasses, sun glasses, or safety glasses)

The film canister MUST be one with a cap that fits INSIDE the rim (such as those used for Fuji® film) instead of over the outside of the rim(such as those used for Kodak® film). Photography shops or film processing operations often have many of these they would otherwise discard or recycle.

Making the Rocket

Students must first decide how to cut their paper. They may cut it the short way or the long way to make the body of the rocket. Emphasize that there is no one right way to make a paper rocket. For example, they may want to try a long, skinny rocket or a short, thick rocket. They may try a sharp nosecone or a blunt nosecone, with fins or without fins. Encourage experimentation!

Here is one idea for cutting the whole rocket from one piece of paper:



Here are the basic steps for making the rocket:

1. Cut out all the pieces for the rocket.

2. Wrap and tape a tube of paper around the film canister. It works best to tape the canister to the end of the paper before wrapping it around the canister.

   It is important to place the lid end of the canister down.

3. Tape fins to the rocket body, if desired.

4. Roll the circle (with a wedge cut out) into a cone and tape it to the rocket's top.

Blasting Off

1. Put on eye protection.

2. Turn the rocket upside down and remove the canister's lid.

3. Fill the canister one-third full of water.

It is important to work quickly on the next steps.

4. Drop one-half of an effervescing antacid tablet into the canister and snap the lid on tight.

5. Stand the rocket on a launch platform, such as the sidewalk or other concrete or asphalt area.

6. Stand back and wait. The rocket will blast off!

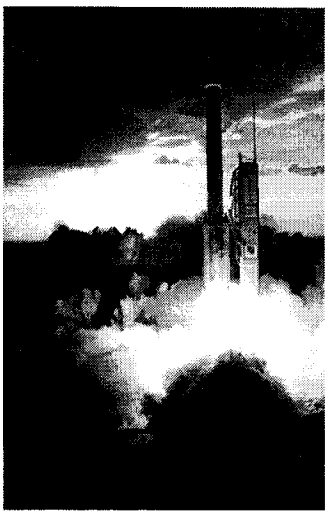
Explaining How it Works

Here is a very simple explanation, which may be elaborated upon for older or more advanced students.

When the effervescent tablet is placed in water, many little bubbles of gas escape. The bubbles go up, instead of down, because they weigh less than water. When the bubbles get to the surface of the water, they break open. All that gas that has escaped from the bubbles pushes on the sides of the canister.

But, unlike a balloon that stretches bigger and bigger when you fill it with gas, the film canister doesn't stretch and all this gas has to go somewhere. Eventually, something has to give! So the canister pops its top (which is really its bottom, since it's upside down). All the water and gas rush down and out, pushing the canister up, along with the rocket attached to it.

Real rockets work similarly. But instead of using tablets that fizz in water, they use rocket fuel.



Delta rocket launching the Deep Space 1 spacecraft from Cape Canaveral, Florida, October 1998.

The rocket that launched Deep Space 1 on October 24, 1998, had four different kinds of engines. Some pushed the rocket off the ground. Then some helped it continue its climb into space. Others gave the Deep Space 1 spacecraft its final push away from Earth. But all of them forced a gas to shoot out of the rocket, thus pushing the rocket the other way.

We call this useful fact the law of action and reaction. The action is the gas rushing out of the rocket. The reaction is the rocket taking off in the other direction. In other words, for every action there is an equal and opposite reaction (Newton's third law). The rocket goes in the opposite direction from the gas, and the faster the gas leaves the rocket, the faster the rocket gets pushed the other way.

You and your students can discover many of the amazing advancements in space technology and have fun in the process by visiting The Space Place on the World Wide Web. You can link to it through ITEA's Web site at http://www.iteawww.org or access it directly at http://spaceplace.jpl.nasa.gov.